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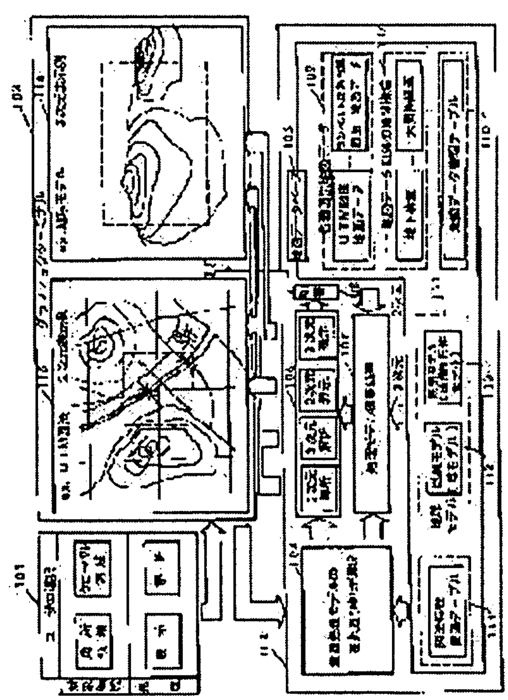
(54) DEVICE AND METHOD FOR MAP PROCESSING

(57)Abstract:

PURPOSE: To provide the device and method for map processing which are suitably used to display and analyze map data regarding a wide area.

CONSTITUTION: The method and device consist of the map data base composed of a map data part 109 for various drawing, a drawing characteristic control table 114 which controls the features of the various drawing, a map data control table 110 which controls map data of the various drawing, and a constant table 111 which generates an earth model for simulating an earth shape, and a three- dimensional/three-dimensional graphic processor and a map processing basic part; and a proper process model is selected according to the characteristics of the drawing and processed. Then when it becomes difficult to analyze the process model because of restrictions of the characteristics of the process model, the analysis is changed to an analysis using another process model.



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1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

CLAIMS

[Claim(s)]
[Claim 1] The map processor characterized by to provide a map data-storage means memorize the map data based on predetermined map projection, a constant table storage means memorized the constant table of the astronomical model for simulating an astronomical configuration, a processing selection means choose processing of said map data, a map data-processing means perform said selected processing, and a display means display the processing result in said map data-processing means.
[Claim 2] The map processor characterized by processing as datum level for said map data's processing of the curved surface of an astronomical model based on said constant table in claim 1.
[Claim 3] The map processor characterize by have a judgment means for judge the propriety of application of said processing by which possessed in claim 1 with the map projection property table which manage further the property in two or more kinds of map projection , its range which can be express , the analysis possible range , and projection proper information , and the selection input be carried out based on said map projection property table .
[Claim 4] The map processor characterized by having further a modification means to change the processing concerned into the processing based on an astronomical model, in claim 3 based on the judgment result by said judgment means.
[Claim 5] The map processor characterized by having a selection means to memorize two or more models of a different precision as said astronomical model in claim 4, and to choose said two or more models according to the demand level of processing.
[Claim 6] The map processor characterized by using an earth model as said astronomical model in claim 5.
[Claim 7] The map data based on two or more kinds of projection, the property managed table which manages the property of said projection, The 1st storage means for storing the constant table of the astronomical model for simulating an astronomical configuration, and the processing program which performs processing based on these, A 2nd storage means to memorize data required for said processing program and processing which were read from said 1st storage means, A data-processing means to process data required for said processing based on said processing program, A display means to display the result of said data processing, and an input means to input information into said data-processing means are provided. The map processor which judges the propriety as a result of said data processing, and is characterized by carrying out data processing based on the constant table of said astronomical model based on said property managed table in the case of no.
[Claim 8] The map data based on two or more kinds of map projection and the data about an astronomical model are memorized in a map database. Analysis processing based on said map projection of 1 chosen from the projection of a class is performed. [two or more] The map art characterized by performing analysis processing based on said astronomical model when it judges whether processing by the projection concerned is appropriate and judges with processing by the projection concerned not being appropriate based on the information on said map database.
[Claim 9] The map art characterized by preparing two or more models of a different precision as said

astronomical model in claim 8, and carrying out analysis processing based on the model of precision according to processing level.

[Claim 10] The map art characterized by giving a three-dimension map indication which took the astronomical configuration into consideration from two-dimensional map data by making the curved surface by the astronomical model into the datum plane of map data control, holding the advanced data to said datum plane of corresponding map data, and holding a means to change into a three-dimension rectangular coordinate system the coordinate value which considered this advanced data.

[Claim 11] The map art characterized by performing the three-dimensional display or analysis which united said map data and the data about said astronomical structure in the map art according to claim 10 by managing the curved surface according the data about astronomical structures other than said map data to an astronomical model as a datum plane of the data concerned.

[Claim 12] The 10th term of a claim and the 11th term are the map art characterized by giving the analysis or the map display according to processing level by having a simple model and a strict model as said astronomical model in the map art of a publication either.

[Translation done.]

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Industrial Application] This invention relates to a map processor and a map art, and relates to a suitable map processor to display and analyze the map data about a large field especially, and a map art.
[0002]
[Description of the Prior Art] Conventionally, the geographical information system with a digital map is mainly used in the field of facility management (water-and-sewage management, road management, a facility, facility management, etc.), town-planning relation (town planning, geography, land use analysis, etc.), and surveys (a photogrammetry, mapping, etc.).
[0003] These systems mainly have many things corresponding to the digital national information and the outline map data format which are offered from the Geographical Survey Institute like the publication to "the newest geographical information system" (pp.96 - 1988 [a magazine "PIXEL", No72, / 120 or]). Since the target field is comparatively local, the scale to deal with is the large-scale map of 1 / 2500 grades, or 1/2.5. The medium scale map of the 10,000th grade is in use.
[0004] Moreover, also about a topographical map, the map maintenance design for a national level is also being planned, and attracting attention increasingly is expected recently.
[0005] The digital map data used with this geographical information system are what digitized the map by various map projection, and it depends for them on the property of that map projection greatly. Moreover, since a map is projection of a up to [the flat surface by two or more kinds of map projection], the digital map data is what was made two-dimensional.
[0006] As described above, since the processing field of the field of the invention of the conventional map processing is local, two-dimensional processing has taken the lead at the flat surface the bottom wholly in the earth front face. Moreover, also when it had altitude value data based on contour-line data, altitude value data were stopped at the three-dimension processing which processes as height from the flat surface used as criteria.
[0007]
[Problem(s) to be Solved by the Invention] A map projects the geographical feature and planimetric features on the front face of the earth on a flat surface according to a certain map projection. Although every place Fig. projection has the property of ******, equivalence nature, and conformality, since it projects earth ellipsoid on a flat surface, it cannot hold all these properties to coincidence. That is, other properties are unsatisfying if its attention is paid to a certain property. For example, the UTM projection applied to the map of a large scale and a medium scale has classified the earth into the zone in every 6 times, in order to make overall distortion in distance small as much as possible, as shown in drawing 5 . Although it is suitable for finding distance in this zone since distortion is comparatively small, a map will become discontinuity every 6 times conversely. Therefore, it is necessary to process the map processing by this UTM system in this zone every 6 times. The distance analysis for two points is possible only in the zone of 6 times, and the count over two or more zones is difficult. Moreover, since the projection near [in UTM projection] two poles becomes infinite distance, near a pole cannot be

inevitably expressed on a map. Thus, every place Fig. projection had the description of a proper, respectively, and when map processing was carried out, there was a problem that it was necessary to carry out while he understands the description enough.

[0008] Moreover, digital map data will be expressed as x, and (y, h) as the position coordinate, if the altitude data from (x, y) or its two-dimensional flat surface are set to h as a position coordinate on a two-dimensional flat surface. In the conventional map processing, since what was necessary was just to have dealt with the local field, flat-surface approximation of the front face of the earth was carried out, said digital map data were used directly, and the two-dimensional display or three-dimensional display which made the flat surface datum level was performed. However, since it was restricted to a partial field, that flat-surface approximation can be performed had the problem of not being suitable in a global display and the analysis (terrestrial scale) of a field in the map processing by the conventional flat-surface approximation. Since flat-surface approximation of the earth front face was carried out when it is specifically going to realize the global three-dimensional display of the bird's-eye view for the whole earth etc. by the conventional map art, there was a problem that it was necessary to close a display compulsorily in the range which serves as an operating space where a horizon does not exist, and does not become unnatural.

[0009] The purpose of this invention is offering the map processor and map art which solve said problem. That is, it is in offering a suitable map processor carrying out display analysis of the map data about a large field, and a map art.

[0010]

[Means for Solving the Problem] The 1st description of this invention for attaining said purpose is having the constant table of the astronomical model for simulating an astronomical configuration, and considering as the datum level for map data's processing of the curved surface of the front face of an astronomical model based on this constant table.

[0011] the 2nd description of this invention be have a means choose the map projection property table which manage the property in two or more kinds of map projection , its range which can be express , an analysis possible range , and projection proper information , the map data control table which manage the digital map data based on two or more kinds of map projection , and the map projection or the model used as criteria according to the processing by which the selection input be carried out .

[0012] The 3rd description of this invention manages the map data based on two or more kinds of map projection, the data about astronomical structures other than map data, and an astronomical model in a map database. By this When the suitable range and analysis possible range of a map display are checked, it judges whether processing by the map projection concerned is appropriate and it judges with processing by the map projection concerned not being appropriate by the judgment result, it is performing processing based on an astronomical model.

[0013] Furthermore, it is also possible to prepare a simple model (ball model) and a strict model (earth spheroid model), and to give the analysis and the map display according to processing level as an astronomical model.

[0014] Here, although a celestial body is a concept including the earth, the moon, a planet, a fixed star, etc., hereafter, the earth is made into an example and explained.

[0015]

[Function] According to this invention, in the analysis on the map projection of 1, or a processing model, the map processing with applicability or the application range is attained from constraint by the property of this map projection or a processing model, maintaining a high precision, since it can change into other map projection or processing models, when analysis becomes difficult.

[0016] For example, the optimal art can be taken by holding the projection property managed table which manages the property and the range which can be expressed in two or more kinds of map projection, an analysis constraint matter, projection proper information, etc., and grasping the description of the map concerned.

[0017] Two-dimensional map data can perform suitable processing also in the field which cannot be processed by holding an earth model and holding the map processing means by the model concerned.

That is, the three-dimension map data which considered the earth configuration from two-dimensional map data by holding an earth model can be generated, and three-dimensional geographical feature can be displayed. Moreover, suitable processing according to processing level can be performed as an earth model by having a simple model (for example, ball model) and a strict model (for example, earth spheroid model).
[0018] Furthermore, a high three-dimensional display and three-dimension analysis of utility value can be performed more by combining the data (for example, a subsurface construction, atmosphere structure in the air, etc.) about earth structures other than map data with map data.
[0019]
[Example] Hereafter, the example of this invention is explained using a drawing.
[0020] As shown in drawing 1 , fundamentally, the map processor of this example consists of the selection-menu input section 101, map processing radical headquarters 102, and a display 103.
[0021] The selection-menu input section 101 consists of the contents of an object domain and its processing, an object domain is classified into a partial field and a global area, and the contents of processing are classified into display processing and analysis processing. The user who is an operator can choose an object domain and the contents of processing suitably according to the purpose of map processing.
[0022] The configuration of map processing radical headquarters 102 becomes from the processing section 104 which chooses the processing section which starts the program over the processing instructed to be a map database 105 by the operator through the selection-menu input section 101, and the optimal map processing model for the processing concerned, the processing section 107 which generate and build the processing model, and the change processing section 108 change the processing section 106, the two-dimensional display, and the three-dimensional display corresponding to an actual display and analysis. In the change processing section 108, although either the two-dimensional display and the three-dimensional display are switched, depending on the capacity of the graphics processing unit mentioned later, a two-dimensional display and a three-dimensional display may be displayed in coincidence juxtaposition, and only a two-dimensional display may only display in three dimensions.
[0023] The map database 105 The various projection map data divisions 109 (UTM projection map data, a lambert conformal-conic-projection map data, etc. are stored), The data division 117 concerning earth structures other than map data according to the need (a subsurface construction, atmosphere structure in the air, etc. are stored), It consists of a projection property managed table 114 which manages the description of various projection, a map data control table 110 which manages the map data of various projection, and a constant table 111 for generating the earth model for simulating an earth configuration.

[0024] The constant table 111 for generating an earth model consists of a constant table 112 for generating the simple model which simplified the earth configuration, and a constant table 113 for generating the strict model for stricter modeling. In this example, the earth ellipsoid model is chosen as the strict model for the ball model as a simple model again.
[0025] A display 103 is a display for displaying the map data and the analysis result which were processed in the map processing radical headquarters 102, and, specifically, the graphics processing unit possessing the function of the two-dimensional display-function section 115 and/or the three-dimensional display function part 116 is used. An example of the range in this example which can be processed is typically shown in drawing 2 . As compared with the case of drawing 3 described below, when there are a processing field 202 by the ball model and a processing field 203 by the earth ellipsoid model, the range which can process only the part has expanded the processing field 201.
[0026] The processing field 301 when two-dimensional processing has taken the lead at the flat surface the bottom wholly in the earth front face at drawing 3 is shown as an example of a comparison. The field which can be processed is local as compared with the case of drawing 2 so that he can understand from drawing 3 .
[0027] The example of a configuration of the map processor using the computer for realizing the function shown in drawing 4 by drawing 1 is shown. In drawing 4 , an auxiliary storage unit 404 stores

the program which processes the map data of various projection, and it. In order that main storage 402 may read the map data stored in the auxiliary storage unit 404 temporarily and may work, the field for storing the program for processing map data etc. is offered. A processing unit 401 reads map data and performs data processing, such as coordinate transformation, judgment processing, etc. for two-dimensional-analyzing, three-dimension-analyzing, and two-dimensional-displaying, and displaying in three dimensions. Two-dimensional / three-dimension graphics processing unit 405 is two-dimensional or equipment which carries out three-dimension graphic operation about graphic data, such as map data. An indicating equipment 406 is equipment which displays map data, a processing result, etc. on a screen. The pointing devices 408, such as a keyboard 407 and a mouse, are for performing an operator's alter operation. A system bus 403 is a data transfer way for sending and receiving data between a processing unit 401, main storage 402, the two-dimensional / three-dimension graphics processing unit 405, and an auxiliary storage unit 404. It is also possible to constitute a processing unit 401, and the two-dimensional / three-dimension graphics processing unit 405 from one workstation.
[0028] Drawing 5 is drawing explaining the UTM projection in the example of this invention, and its discontinuity. Moreover, drawing 6 is drawing explaining the distance count by the UTM projection which is an example of data processing in the example of this invention.
[0029] As shown in drawing 5 and drawing 6 , in order to make overall distortion in distance small as much as possible, the UTM (Universal Transverse Mercator) projection applied to the map of a large scale and a medium scale classified the earth into the zone 502 in every 6 times centering on the central circles of longitude 503, and has projected it on the cylinder-like plane of projection 501.
[0030] In this zone 502 in every 6 times, since distortion is comparatively small, it is suitable for finding distance, but conversely, as signs 504 and 505 show, a map will become discontinuity for every zone of 6 times. The distance count 602 only in the zone of 6 times is possible for the distance analysis for two points (R> drawing 6 6 upper case), and the distance count 603 over two or more zones is difficult (drawing 6 lower berth). Therefore, it is necessary to carry out computation of the map processing by this UTM system for every zone of 6 times. Moreover, since the projection near [in UTM projection] two poles becomes infinite distance, near a pole cannot be inevitably expressed on a map.
[0031] Thus, each projection has the description of a proper, respectively, and when carrying out map processing, it needs to perform it corresponding to the description of each projection used for processing.
[0032] An example of the processing flow in this example is shown in drawing 7 .
[0033] At step 701, the map processing program of this example is started, initialization of a working area and initial setting of a program are performed, and the menu about map processing is displayed on a screen. At step 702, processing from step 703 to step 711 is repeated and processed until there are processing termination directions by the operator. At step 703, selection processing of either two-dimensional map means of displaying or three-dimension map means of displaying is carried out based on directions of an operator. Two-dimensional map display processing is performed at step 704. Three-dimension map display processing is performed at step 705. At step 706, repeat processing is carried out for from step 707 of Ushiro who displayed the map on the screen by two-dimensional map display processing or three-dimension map display processing to the step 711. At step 707, selection processing of either change processing of the means of displaying of screen control processing of the map currently displayed, analysis processing of a map, two-dimensional, or a three dimension or a processing post process is carried out based on directions of an operator. At step 708, screen control processing of expansion of the displayed map, contraction, scrolling, etc. is performed. At step 709, analysis processing of distance, area, or the volume is carried out based on the map displayed on the screen. At step 710, processing for the change of two-dimensional map means of displaying and three-dimension map means of displaying is performed based on directions of an operator. At step 711, directions of an operator perform a processing post process, it escapes from processing of step 702 and the map processing by the example of this invention is ended.
[0034] Next, the coordinate management method and transform processing which used the earth model in a three-dimension map display process are explained concretely. Moreover, by the projection

concerned, the concrete art about the thing in consideration of an earth configuration done for three-dimension analysis processing is explained by judging automatically the processing field where analysis is difficult, and holding an earth model from constraint of projection, when the analysis on a map becomes difficult.

[0035] An operator displays a map on a screen through a map processing system, does still more nearly various analysis processings on the screen, hangs feedback further, and continues processing. However, an operator is difficult for choosing an always suitable map processing model and performing suitable processing to what he is going to carry out on a map. Although a map is expressed by various kinds of projection and it is necessary to use it according to the application, as for processing, while an operator takes the property of the map of various projection into consideration, working efficiency worsens very much. For example, in UTM projection, as shown in drawing 6 , since a calculation error becomes large, it is meaningless to carry out distance count in 6 times or more. In the example of this invention, the map database which also took the property of the projection of such a map into consideration is built, and the method which judges automatically the range of a calculation error which becomes large is taken.

[0036] An example of the map database structure of the example of this invention is shown in drawing 13 from drawing 8 . Drawing 8 is the map data control table 801 (it corresponds to the sign 110 of drawing 1) which manages the map data of the whole map database. Map data have structure managed for every projection. On the map managed table 801 The number of the projection registered into the database The shown number information 805 of registered projection, the number information 806 corresponding to the projection which is the case number of the projection to which a projection property managed table (sign 114 of drawing 1) corresponds, the number information 807 of scales, the scale information 808, the number information 809 of registered map leaves that shows the number of the map leaves registered into the database, and each map leaf range The lower limit information 813 on the 812 LAT upper-limit information on the 811 LAT **** value information on the 810 LONG **** value information on the shown LONG and the map data storage point pointer 819 concerned, and the additional information 820 about projection are stored as main management items. Here, if an example of additional information 820 is given, there is a zone No of UTM in the case of UTM projection.

[0037] Drawing 9 is the projection property managed table 901 (it corresponds to the sign 114 of drawing 1) which carried out classification arrangement of the property of projection. The main management items For identifying the map data based on the projection ID information 904 for identifying the classification of the total number information 903 of cases corresponding to the number of classification of the projection to manage, and projection, and normalization system of coordinates, specially The projection partition information 905, the main projection classification information 906-911, the range information 912-915 on LAT LONG that can be expressed, It consists of the applicability and the range information 916-924 on the analysis (for example, distance, area, volume) of the projection concerned, and projection proper information 925. Here, as an example of the projection proper information 925, there is a location of the range of the zone No in UTM projection and criteria circles of longitude etc. On this table 901, even the projection ID information 904 - the projection proper information 925 are managed as information 902 on 1 case eye.

[0038] The projection property managed table of UTM projection is shown in drawing 10 as an example of the projection property managed table 901. As projection ID information 1001 for identifying the classification of projection, "UTM", As projection partition information 1002 specially in order to identify the map data based on normalization system of coordinates "0", As main projection classification information 1003-1008, "0, 0, 1, 1, 0, 0" the range information 1009-1012 on (that is, they are cylindrical map projection and right spur projection) and LAT LONG which can be expressed -- "--0, 360, -80, and 80" -- The distance of the projection concerned, area Or the analysis possible existence used as the criteria of an analysis possible judging of bearing The shown information 1013, 1016, and 1019, the LONG in which analysis is possible And it consists of information 1014, 1015, 1017, 1018, 1020, and 1021 on the range of the direction of the LAT, and projection proper information 1022 (the minimum value 1023 of zone No., the maximum 1024 of zone No., location 1025 of criteria circles of

longitude). More, as shown in drawing 10 , in the case of UTM projection, the information 1013 (the impossible is shown, if it is 1 and is the possibility of and 0) which shows distance analysis possible existence, the information 1016 (the impossible is shown, if it is 1 and is the possibility of and 0) which shows area analysis possible existence, the information 1019 (the impossible is shown, if it is 1 and is the possibility of and 0) which shows bearing analysis possible existence, and be used for distance analysis be shown because of "1, 0, 0", respectively.

[0039] The case of the map of geographic coordinate rectangular cross normalization projection is similarly indicated to be drawing 10 to the example as an example of the projection property managed table 901 at drawing 11 . As projection ID information 1101 for identifying the classification of projection, "NRM", As projection partition information 1102 specially in order to identify the map data based on normalization system of coordinates "1" (it is shown that it is map data based on normalization system of coordinates), As main projection classification information 1103, "0, 0, 0, 0, 0, 0" (it is shown that it is applied to neither), the range information 1104-1107 on LAT LONG which can be expressed -- "-- it consists of 0, 360, -80, 80", the distance used as the criteria of an analysis possible judging of the projection concerned, area, information 1108 on the range of bearing, and projection proper information 1109.

[0040] Drawing 12 shows an example of map DS. As main classes of map data, there are the segment data table 1201, a notation data table 1202, and an alphabetic character data table 1203. The layer classification is carried out as a common element, and these data tables have advanced data, and have location data showing those physical relationship. For example, the case of location data, or (LONG lambda, LAT phi) (x, y) can be considered. Moreover, when based on UTM projection, (x, y), and other general projection can consider (lambda, phi).

[0041] An example of the relation of the map database structure by the example of this invention was shown in drawing 13 . The number 1 (sign 1305) corresponding to projection in the map data control table 1301 is connected with the projection A1308 to which the projection property managed table 1302 corresponds. Moreover, the map data storage point pointer 1306 of a map data control table is connected with the "map leaf 1" to which the map data file 1303 corresponds for every projection. The number 3 (sign 1307) corresponding to projection of a map data control table is connected with the projection C (sign 1310) to which the projection property managed table 1302 corresponds.

[0042] Moreover, in the map database 105 in the example of this invention, as shown in drawing 1 etc., in order to generate three-dimension map data from two-dimensional map data, and in order to enable analyses, such as suitable distance count in a global field (large field which makes the whole earth a processing object), the constant table 111 of an earth model is held. Moreover, the constant table 111 of this earth model is classified into the constant constant table 112 and 113 of a strict model of a simple model in order to be able to perform the analysis according to processing level, and a map display.

[0043] The constant table of the ball model which is one example of the constant table 112 of this simple model is shown in drawing 14 . A ball model can consider three models, 3 shaft arithmetical-mean ball model, a spheroid surface area equivalence ball model, and a spheroid volume equivalence ball model, with an observing point. The constant table has data "3" 1401 of the ball model number which shows that there are three models, the data 1402 (6370. 291km) of the radius of 3 shaft arithmetical-mean ball model, the data 1403 (6370. 290km) of the radius of a spheroid surface area equivalence ball model, and the data 1404 (6370. 283km) of the radius of a spheroid volume equivalence ball model.

[0044] The constant table of the earth ellipsoid model which is an example of the constant table 113 of a strict model is shown in drawing 15 . As an earth ellipsoid model, two models, the bessel spheroid model 1502 and IUGG land survey frame-of-reference 1980 model 1503, can be considered. On the earth ellipsoid model constant table 1501 The data 1504 of an earth ellipsoid model number in which it is shown that there are two models, the data 1505 (6377397. 155m) of the major-axis radius a of a bessel spheroid model, The data 1506 (6356078. 96325m) of the minor-axis radius b, the data 1507 (0.006674372231315) of e2, and the data 1508 (0.003342773181579) of Ellipticity f, The data 1509 (6378137m) of the major-axis radius a of IUGG land survey frame-of-reference 1980 model, It has the

data 1510 (6356752. 3141m) of the minor-axis radius b, the data 1511 (0.00669438002290) of e2, and the data 1512 (0.00335281068118) of Ellipticity f.
[0045] Drawing 16 , drawing 17 , and drawing 18 explain the expansion approach from the two-dimensional map data in the example of this invention to earth model three-dimension rectangular coordinate system map data. In addition, the expansion approach to the earth model three-dimension rectangular coordinate systems (a subsurface construction, atmosphere structure in the air, etc.) of the data about earth structures other than map data is possible similarly.
[0046] First, with reference to the map data control table (drawing 1 : 110) of a map database (drawing 1 : 105), it checks whether there are any map data of the projection concerned. In a certain case The specified map data area () [<A HREF="/Tokujitu/tjitemdrw.ipdl?N0000=237&N0500=1 E_N/;?9?989?:///&N0001=247&N0552=9&N0553=000003"] TARGET="tjitemdrw"> drawing 1: Search the map leaf of 109 and generate three-dimension data for the map data of the map leaf of the map data file (drawing 1 3:1303) which a map data storage point pointer shows concerned with the readout one by one to main storage (drawing 4 : 402).
[0047] Ellipticity f (flattening) is about 1/300, it can consider in simple that the earth is a ball as the 1st approximation, and it can simplify an earth model. When there is no need of taking the ellipticity of the earth into consideration, all are processed with a simple model the bottom as a ball in the earth. Moreover, when the earth needs to be expressed as an earth spheroid strict in geodesy, the earth is wholly processed with a strict expression the bottom as a spheroid. Let the above be the selection criterion of a simple expression and a strict expression. In a simple expression, in 1610 and a strict expression, 1611 is chosen by the selection processing 1609 by the display precision prescribe.
[0048] In a simple expression, 1610 performs computation 1602 by the simple model (for example, ball model) of an earth model. If lambda and LONG data are [phi and the contour-line data of the read map data] h for example, for LAT data, each constituting point coordinate or normal coordinate data will be given by A(lambda, phi, h) 1601. If the radius of the earth is set to r and illustrated, it will become like A point 1705 shown in drawing 17 . the value of the coordinate point A(x y, z) 1705 searched for from the geometric relation shown in drawing 17 R> 7 -- the following formulas (several 1) -- and (several 2) (several 3) it is expressed.
[0049]
x=(r+h) sinlambda -- (several 1)
y=(r+h) coslambda -- (several 2)
z=(r+h) sinphi -- (several 3)
At this time, the value of the ball model constant table (it corresponds to the signs 1604, 1605, and 1606 in drawing 16) of drawing 14 is used as a value of r. For example, the data 1402 (6370. 291km) of the radius of 3 shaft arithmetical-mean ball model are used.
[0050] Moreover, in a strict expression, 1611 performs computation 1603 by the strict model (for example, earth ellipsoid model) of an earth model.
[0051] The map data read from the auxiliary storage unit (drawing 1 : 404) are similarly given by A (lambda, phi, h) 1601. When the radius of the earth is set to r and illustrated, it is shown by A point 1805 with the earth ellipsoid model of the strict model shown in drawing 18 R> 8. the value of point A0 (x0, y0, z0) 1806 on the ellipsoid side searched for from the geometric relation shown in drawing 18 -- the following formulas (several 4) -- and (several 5) (several 6) it is expressed.
[0052]
x0=Ncosphicoslambda -- (several 4)
y0=Ncosphisinlambda -- (several 5)
z0=N(1-e2) sinphi -- (several 6)
Here, the value of N is expressed by the following formulas (several 7). Moreover, e2 is square [of Eccentricity e (eccentricity)], and, in the case of a bessel spheroid model, in the case of data 1507 (0.006674372231315) and IUGG land survey frame-of-reference 1980 model, it is the data 1511 (0.00669438002290) of e2.
[0053]

N=a/root (1-e2sin2phi) -- (several 7)
Therefore, the value of the coordinate point (x y, z) of Point A is as follows.
[0054]
X=Ncosphicoslambda+h-sinlambda -- (several 8)
Y=Ncosphisinlambda+h-coslambda -- (several 9)
z=N(1-e2) sinphi+h-sinphi -- (several 10) As mentioned above, it can develop from the two-dimensional map data A(lambda, phi, h) 1601 to the earth model three-dimension rectangular coordinate system map data A(x y, z) 1612. If a constituting point can be developed to the rectangular coordinate system of the three dimension in 3D-Graphics, since it can display in three dimensions, the map data which consist of LAT data, LONG data, and contour-line data are fundamentally understood that the three-dimensional display based on an earth model is possible from formula (several 1) - (several 3) and (several 7) - (several 10).
[0055] Next, taking the case of the distance analysis in UTM projection, it explains as an example of the analysis approach of the global (terrestrial) scale by this example.
[0056] The outline of processing is shown in drawing 19 . An object domain is a global area and it is chosen by the input from the selection-menu input section (drawing 1 : 101) which is not illustrated in drawing 19 that processing is analysis processing. The map data for analysis are displayed on the map display screen 1901, two A and B are specified on a screen (processing 1902), and the data 1904 of the coordinate value A of the specified point (x1, y1, n1) and the data 1905 of B (x2, y2, n2) are acquired (processing 1903). At this time, UTM zone No. of the map leaf concerned is also acquired from a map data control table (drawing 1 : 110) to coincidence. Next, a coordinate value is changed into the LONG and the LAT which is to the base of analysis (processing 1906). Here, a coordinate value A (x1, y1, n1) and a coordinate value (x2, y2, n2) B mean the coordinate in a UTM system. n1 and n2 are the zone numbers in UTM projection. x1 And x2 It is the coordinate value of the direction of LONG in the zone concerned, and a unit is meter. y1 and y2 are the coordinate values of the direction of the LAT in the zone concerned, and the unit is the same as that of x1 and x2. this coordinate transformation -- being related -- for example -- mathematical basic present age surveying [ ] of "survey -- the 1st -- what is indicated by volume"pp.101-pp.102, and (Japanese Association of Surveyors and May 25, Showa 56 issue) can be used. B (lambda2, phi2) processing 1906 -- the LONG and the LAT coordinate value A from UTM / LONG, and a LAT coordinate transformation equation (lambda1, phi1) -- it asks.
[0057] Next, the projection property managed table 1909 is used. The term of a distance analysis possible judging of UTM projection (drawing 10 : 1013-1015), Judge (processing 1908), and if A (lambda1, phi1) for which it asked previously from the term (drawing 10 : 1023-1025) of projection proper information, and B (lambda2, phi2) are among [the same zone] six LONG width of face, whether it is in the same zone of six LONG width of face Projection property use processing 1911 in which the property of the projection concerned was employed efficiently is carried out. In this case, the distance S for two points becomes as a formula (several 11) 1912, and can be found as an analysis result 1916.
[0058]
S=root (X2-X1) (2+(Y2-Y1) 2) -- (several 11) Conversely, when separating from the same zone of six LONG width of face, since it cannot process, by the projection concerned, earth model application processing 1913 which applies an earth model is carried out. This processing 1913 has two models corresponding to the processing level according to the count precision demanded. Although one model is uniformly applicable to a large-scale-into - range, it is the model (this performs ball model analysis processing 1914) with which count precision falls, and the model of another side is a model (this performs mean-curvature radius application processing 1915) which can apply only to a middle-scale range, instead precision goes up. Earth model application processing 1913 is performed using the ball model constant table 1910. An analysis result 1916 can be found as a distance S for two points.
[0059] Drawing 20 shows the geometric relation at the time of finding distance by ball model analysis processing (drawing 1 9:1914). This model is wholly equivalent to a model the bottom in the ball which equalized the earth, and the radius of a ball is fixed. Fundamentally, the distance for two points is

found using the property of a spherical-surface right triangle. If distance AB to find is set to S, distance AC is set to b and distance BC is set to a r'=DA=DC=rcos phi 1 -- (several 12) b=(rcosphi1) - deltalambda [rad] -- (several 13) A=r-deltaphi [rad] -- (several 14) From the property of a spherical-surface right triangle cos(S/r) =cos (a/r), cos (b/r) -- (several 15) S=rcos -1 (cos (a/r), cos (b/r)) It is shown by -- (several 16).
[0060] Drawing 21 shows the processing outline at the time of performing mean-curvature radius application processing (drawing 19 R> 9:1915). This model searches for the mean-curvature radius in the point of the arbitration on a spheroid side, and near an any selected point, since it becomes equivalence mostly with an actual spheroid, it is called for with a comparatively sufficient precision in a middle-scale range centering on this point. Moreover, this radius changes dynamically according to the curvature of a field. When finding the distance for two points, this any selected point will be chosen at the middle point of two points. This middle point is ((lambda1+lambda2)/2 and (phi1+phi2)/2). According to reference "map projection" pp.11-13 (Nomura forward 7 work, Japan Map Center, November 30, Showa 58 issue), a formula (several 16) is asked for the distance S for two points with the application of a formula (several 17).
[0061]
r=(aroot (1-e2))/(1-e2sin2 (phi1+phi2) (/2) -- (several 17) as mentioned above, by this example) Since two-dimensional processing is performed when sufficient precision can be taken out with two-dimensional processing, and three-dimension-processing is performed when precision does not come out by two-dimensional processing, it is not necessary to consider hardware as a superfluous configuration, an efficient system can be built, and it can consider as the system which is excellent in portability. Here, one example of the decision criterion in the case of the ability to take out sufficient precision with two-dimensional processing is described. It is 0.1km about the allowable error of distance count. The distance count range which can be processed two-dimensional is 0-230km to press down with extent. Moreover, the distance count range which can be processed two-dimensional is 0-500km to press down the allowable error of distance count by about 1km. If the aforementioned range is crossed, it will be judged as the case where precision does not come out by two-dimensional processing.
[0062] Furthermore, according to this example, by managing the curved surface by the earth model similarly as datum level of the data concerned, the data about earth structures other than map data can also realize the three-dimensional display and analysis which united a subsurface construction, atmosphere structure in the air, etc. and map data, and become analyzable [a weather report a geological survey, and also an earthquake].
[0063] Furthermore, even when analyses, such as constraint by the property of projection to distance, become difficult in the analysis on a map according to this example, it can analyze by taking an earth configuration into consideration again. Moreover, in the same system, the three-dimension map data which considered the earth configuration from two-dimensional map data can be generated, and a three-dimension map display can be performed. Furthermore, in analysis processing, the analysis which suited rice cake processing level in the simple model and the strict model is possible. Therefore, since the same map processing system can be used and it can display from a two-dimensional map display to a three-dimension map display from a local field to a global field in map processing, it becomes possible to perform large map processing of applicability with a sufficient precision.
[0064] And it consists of a map database which consists of a constant table 111 which generates the earth model for simulating the map data of various projection, the projection property managed table 114 which manages the description of various projection, the map data-control table 110 which manages the map data of various projection, and an earth configuration, two-dimensional / three-dimension graphics processing unit, and map processing radical headquarters, and, according to this example, a suitable processing model chooses and processes based on the property of projection. And in the analysis on the processing model of 1, since it can carry out by changing into the analysis in other processing models when the analysis from constraint by the property of this processing model becomes difficult, large map processing of applicability is attained.
[0065] In this example, although the earth model has been described for the example, even if it is other

celestial bodies, such as the moon which serves as a candidate for a display / analysis using map projection, a planet, and a fixed star, it is applicable similarly.

[0066]

[Effect of the Invention] According to this invention, a suitable map processor to carry out display analysis of the map data about a large field and a map art can be offered.

[Translation done.]

* NOTICES *

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] The explanatory view of the outline of map mode of processing in the example of this invention.
[Drawing 2] The explanatory view of the analysis possible range in the map processing in the example of this invention.
[Drawing 3] The explanatory view of the analysis possible range in map processing of the example of a comparison.
[Drawing 4] The explanatory view of the example of a computing system configuration in the example of this invention.
[Drawing 5] The UTM projection in an example and the discontinuous explanatory view of this invention.
[Drawing 6] The explanatory view of the distance count by the UTM projection in the example of this invention.
[Drawing 7] The explanatory view of the whole processing flow in the example of this invention.
[Drawing 8] The explanatory view of the map data control table in the example of this invention.
[Drawing 9] The explanatory view of the projection property managed table in the example of this invention.
[Drawing 10] The explanatory view of the example 1 (in the case of UTM projection) of a projection property managed table in the example of this invention.
[Drawing 11] The explanatory view of the example 2 (in the case of a geographic coordinate rectangular cross normalization map) of a projection property managed table in the example of this invention.
[Drawing 12] The explanatory view of the example of map DS in the example of this invention.
[Drawing 13] The explanatory view of the example of a map database structure in the example of this invention.
[Drawing 14] The explanatory view of the ball model constant table in the example of this invention.
[Drawing 15] The explanatory view of the earth ellipsoid model constant table in the example of this invention.
[Drawing 16] The explanatory view of the expansion approach to the earth model three-dimension rectangular coordinate system of the map data in the example of this invention.
[Drawing 17] The explanatory view of the ball model in the example of this invention.
[Drawing 18] The explanatory view of the earth ellipsoid model in the example of this invention.
[Drawing 19] The explanatory view of the example of analysis processing of the global scale in the example of this invention.
[Drawing 20] The explanatory view of the ball model analysis processing in the example of this invention.
[Drawing 21] The explanatory view of the mean-curvature radius application processing in the example of this invention.
[Description of Notations]

102 -- Map processing radical headquarters, 103 -- A display, 104 -- Processing which chooses the optimal map processing model, 105 -- A map database, 106 -- Processing corresponding to an actual display and analysis, 107 -- The processing, 111 which generate and build a processing model -- The constant table for generating an earth model, 114 -- A projection property managed table, 401 -- A processing unit, 402 -- Main storage, 403 -- A system bus, 404 -- An auxiliary storage unit, 405 -- Two-dimensional / three-dimension graphics processing unit, 406 -- An indicating equipment, 407 -- A keyboard, 408 -- POINTIGU device, 806 -- The table corresponding to projection, 906-911 -- A projection classification, 925 -- Projection proper information, 1402 [-- A bessel spheroid model, 1503 / -- IUGG land survey frame-of-reference 1980 model.] -- 3 shaft arithmetical-mean ball model, 1403 -- A spheroid surface area equivalence ball model, 1404 -- A spheroid volume equivalence ball model, 1502

[Translation done.]

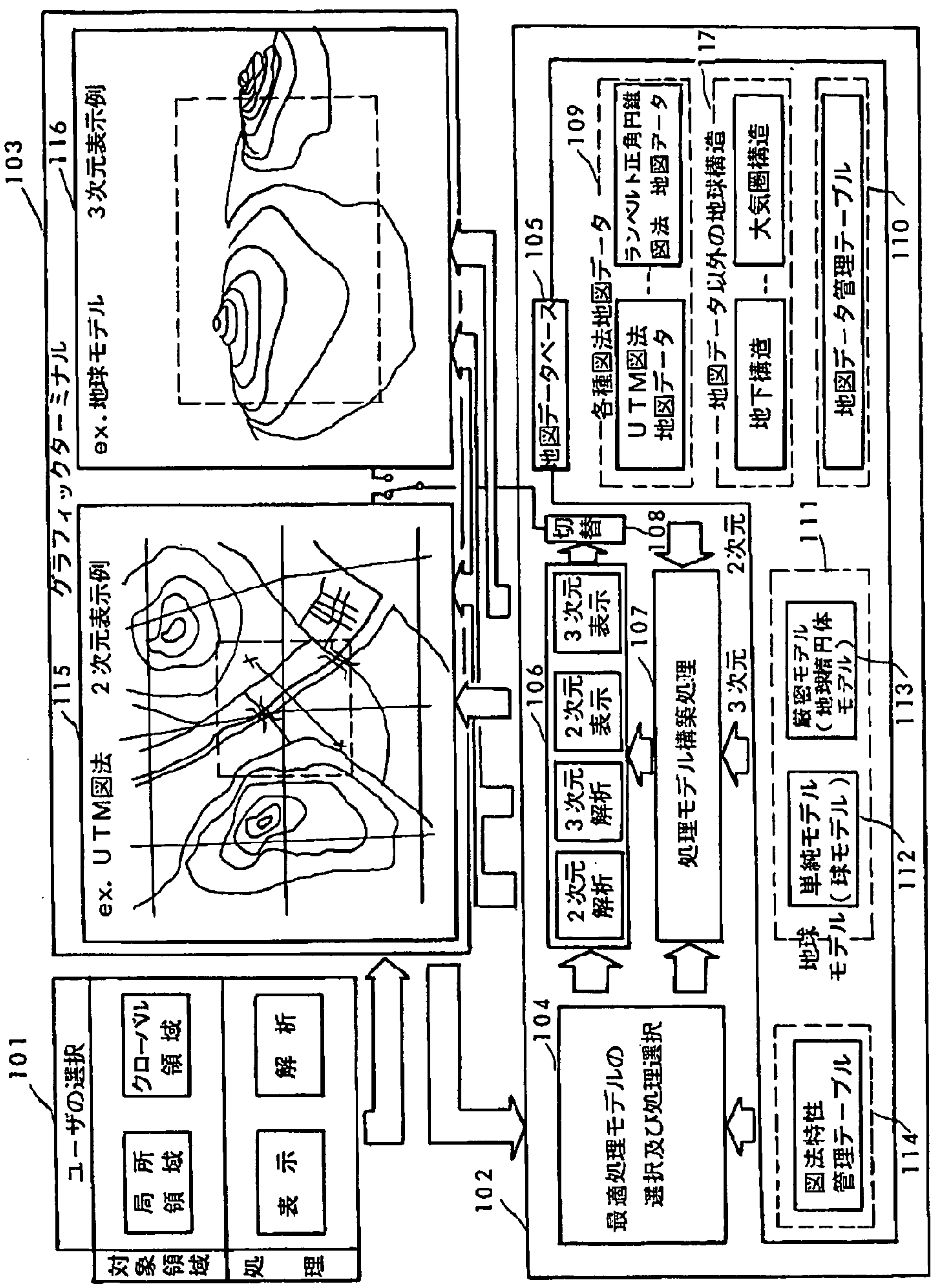
* NOTICES *

1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

DRAWINGS

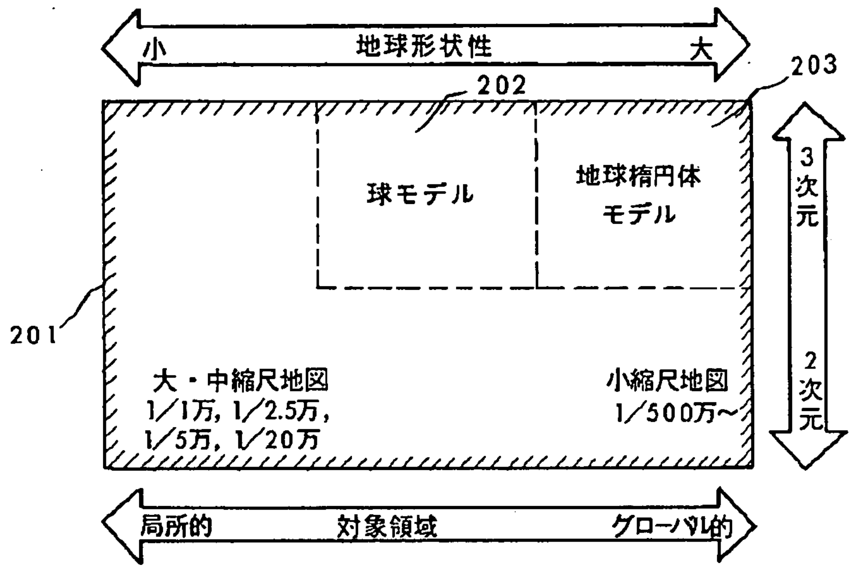
[Drawing 1]

図 1


101
ユーザの選択
対象領域
局所領域
グローバル領域
処理
表示
解析
102
104
最適処理モデルの選択及び処理選択
103
グラフィックターミナル
115
ex. UTM図法 2次元表示例
116
ex. 地球モデル 3次元表示例
105
地図データベース
106
2次元解析
3次元解析
2次元表示
3次元表示
107
処理モデル構築処理
108
切替
3次元
2次元
109
各種図法地図データ
UTM図法地図データ
ランベルト正角円錐図法 地図データ
117
地図データ以外の地球構造
地下構造
大気圏構造
110
地図データ管理テーブル
111
地球モデル
単純モデル（球モデル）
112
綿密モデル（地球楕円体モデル）
113
114
図法特性管理テーブル

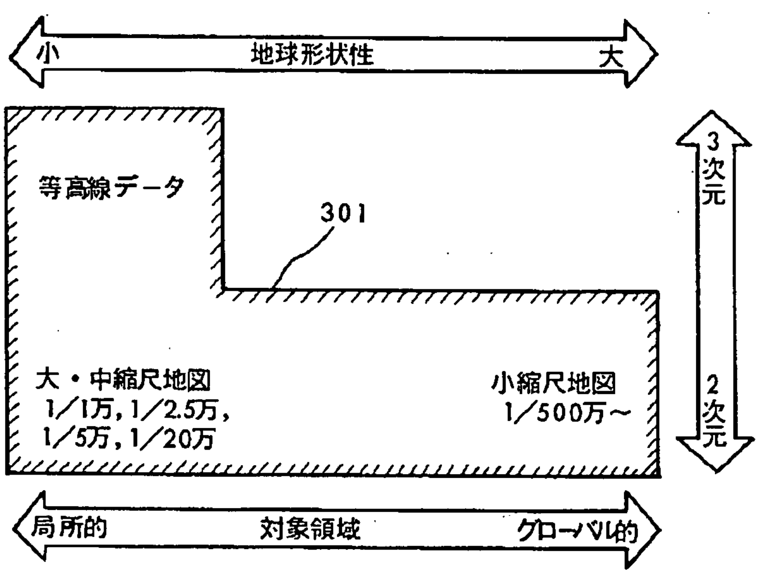
[Drawing 2]

図 2



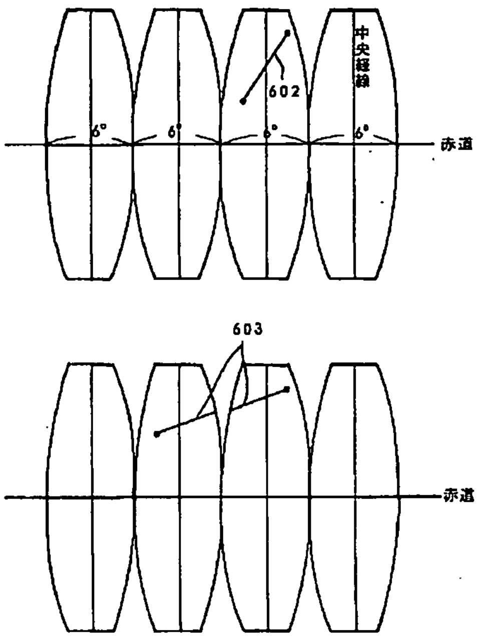
[Drawing 3]

図 3



[Drawing 6]

図 6



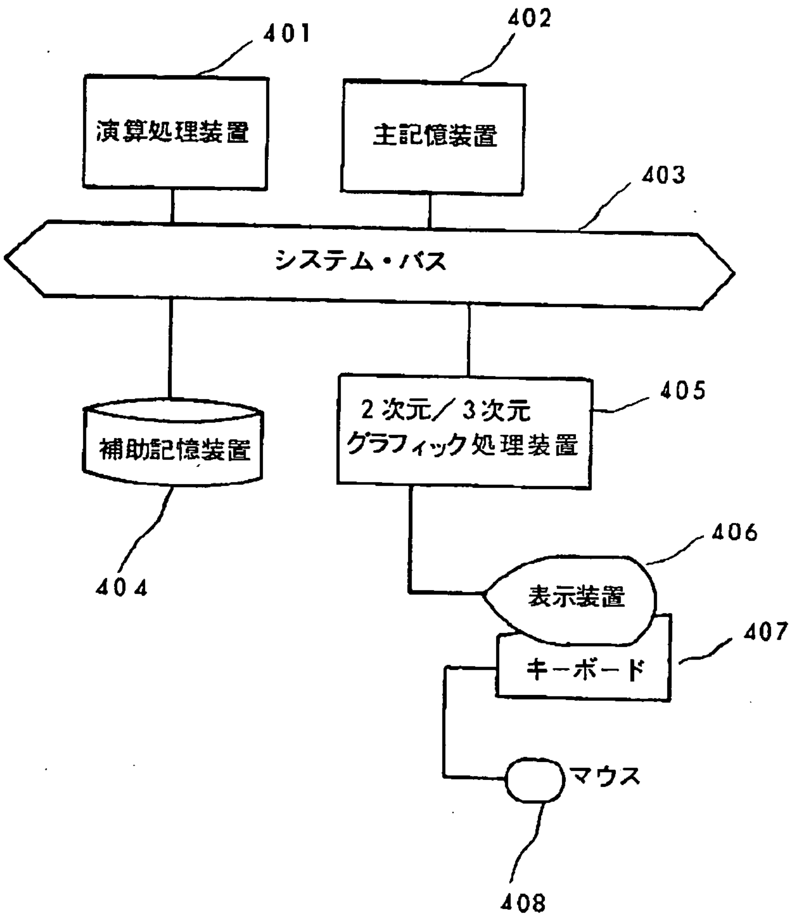
[Drawing 14]

図 14

球モデル数		3	1401
モデルの半径(km)	3軸相加平均球モデル	6370.291	1402
	回転楕円体表面積等価球モデル	6370.290	1403
	回転楕円体体積等価球モデル	6370.283	1404

[Drawing 4]

図 4



[Drawing 15]

図 15

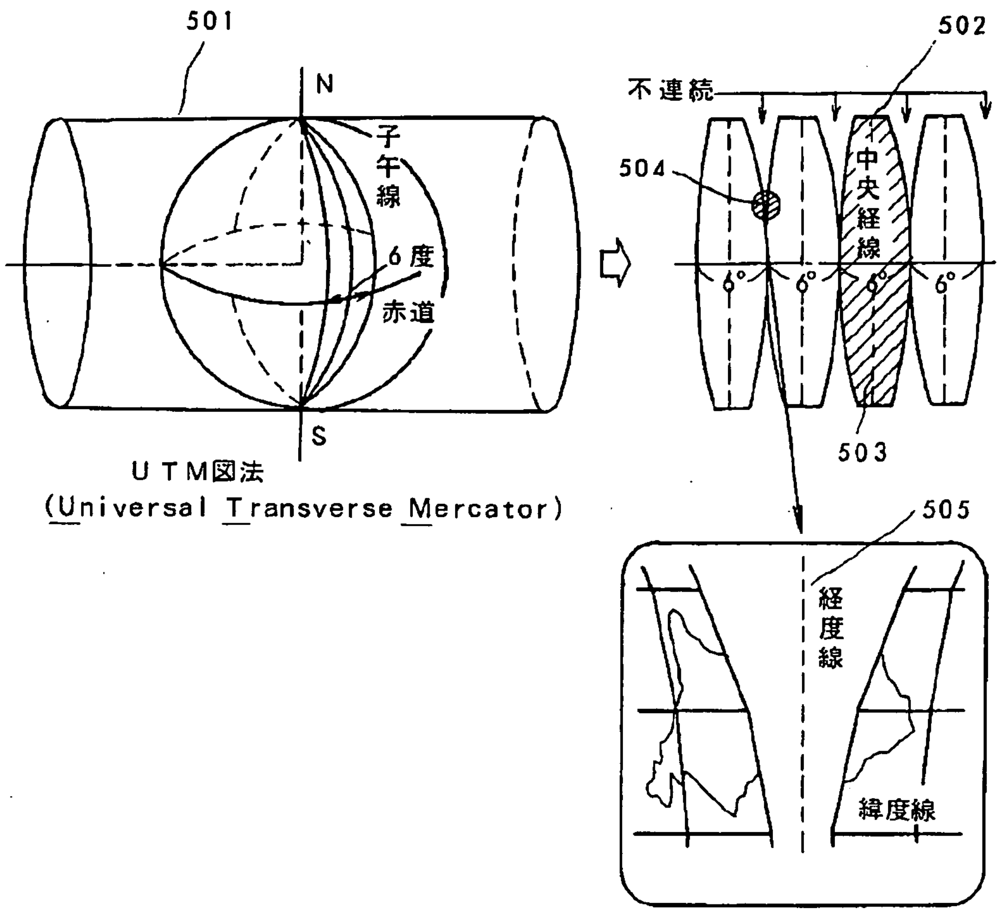
1502

地球楕円体モデル数		2	1504
ベッセル回転楕円体	a （長軸）	6377397.155	1505
	b （短軸）	6356078.96325	1506
	e^2	0.006674372231315	1507
	f （扁平率）	0.003342773181579	1508
IUGG測地基準系1980	a （長軸）	6378137	1509
	b （短軸）	6356752.3141	1510
	e^2	0.00669438002290	1511
	f （扁平率）	0.00335281068118	1512

1501 1503

[Drawing 5]

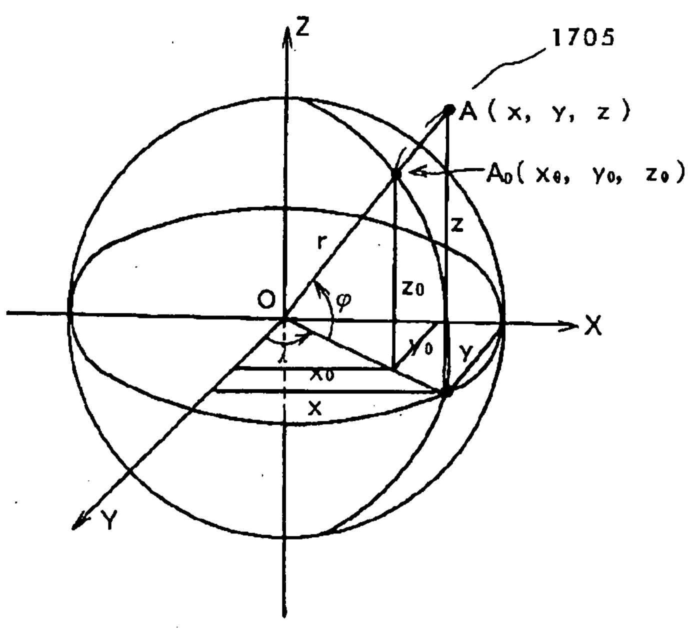
図 5



UTM座標系

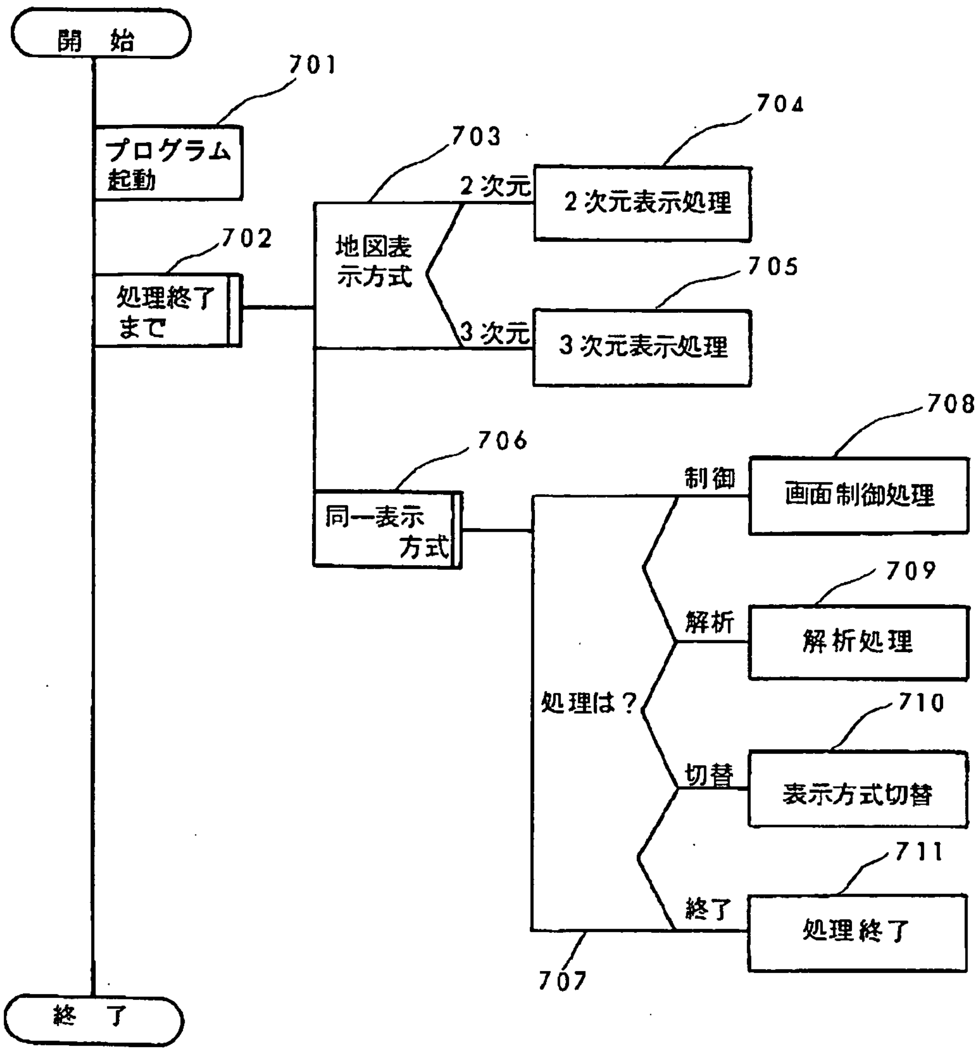
[Drawing 17]

図 17



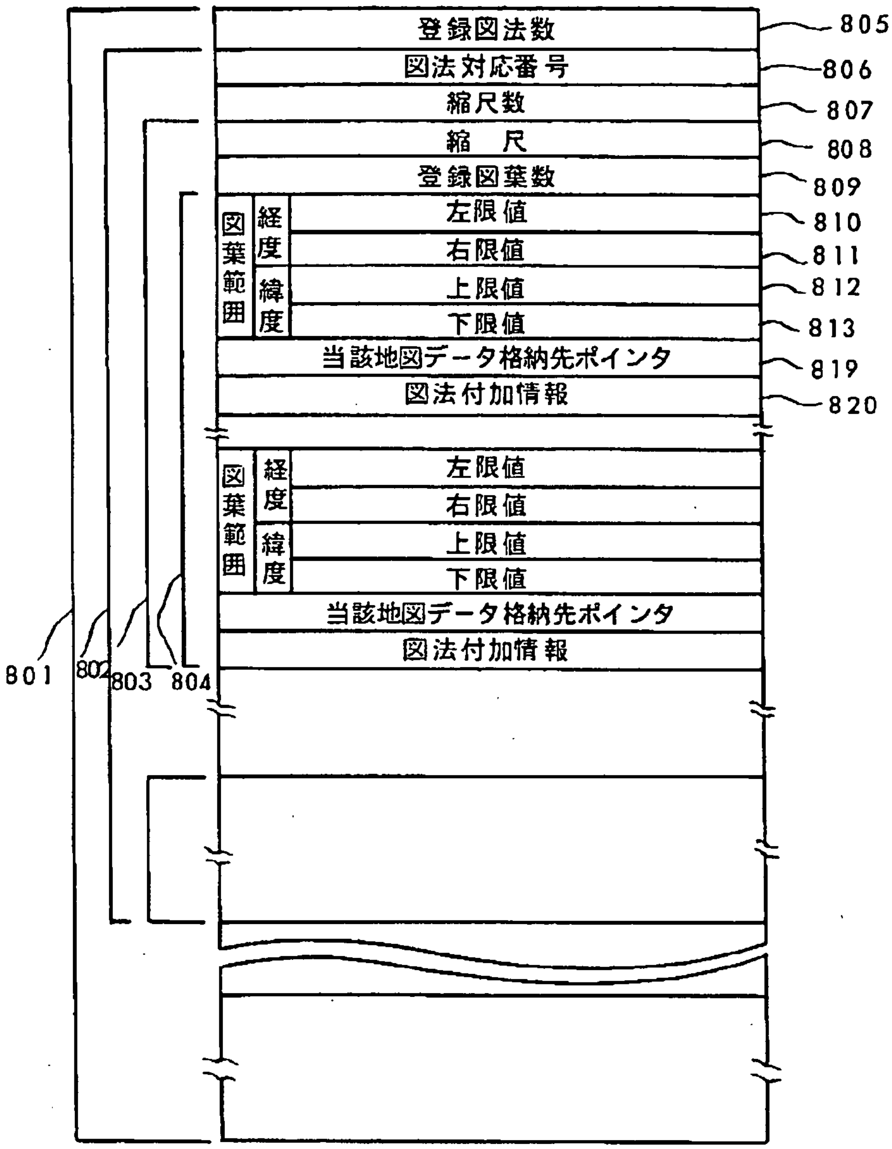
[Drawing 7]

図 7


開 始
701
プログラム起動
702
処理終了まで
703
地図表示方式
2次元
3次元
704
2次元表示処理
705
3次元表示処理
706
同一表示方式
処理は？
707
制御
708
画面制御処理
解析
709
解析処理
切替
710
表示方式切替
終了
711
処理終了
終 了

[Drawing 8]

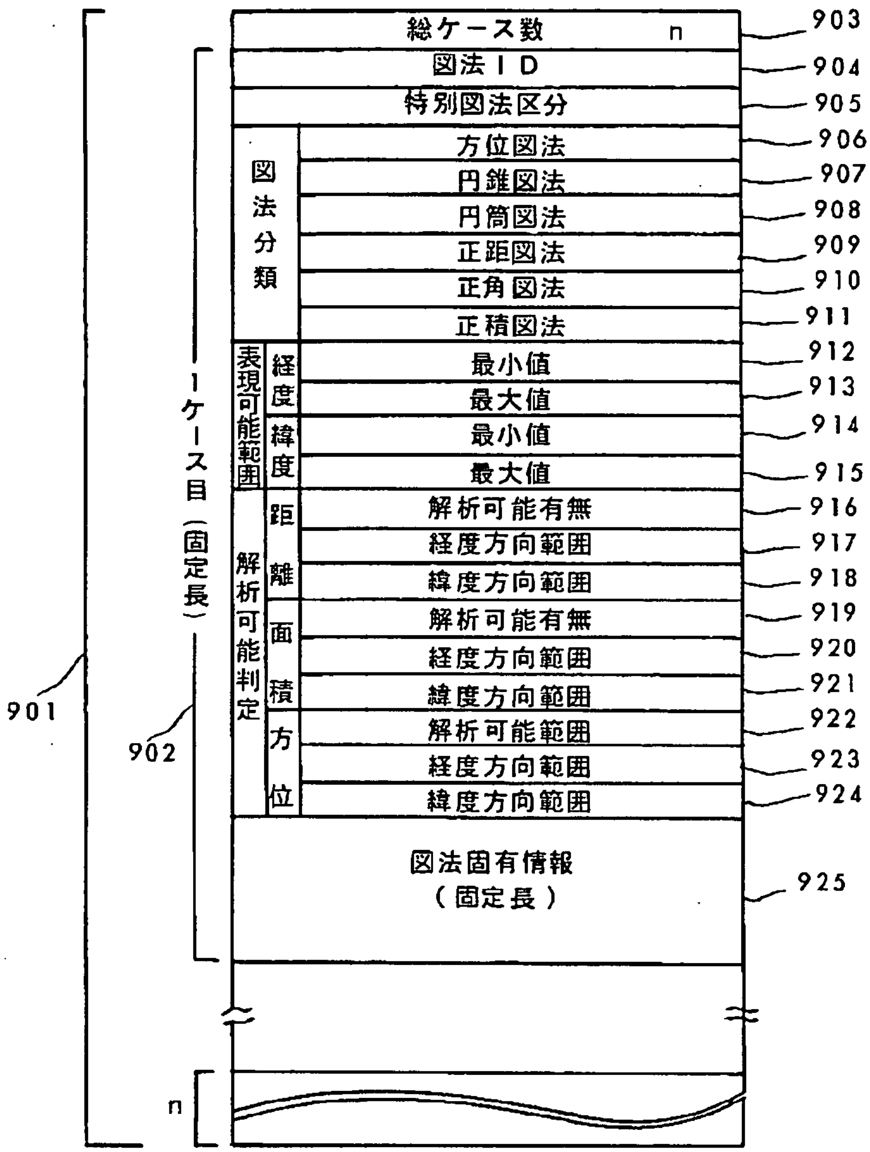
図 8



図法付加情報：ＵＴＭ図法の場合はゾーンNo.を格納

[Drawing 9]

図 9



[Drawing 10]

図 10

図法ＩＤ			UTM	1001
特別図法区分			0	1002
図法分類		方位図法	0	1003
		円錐図法	0	1004
		円筒図法	1	1005
		正距図法	1	1006
		正角図法	0	1007
		正積図法	0	1008
表現可能範囲	経度	最小値	0	1009
		最大値	360	1010
	緯度	最小値	−80	1011
		最大値	80	1012
解析可能判定	距離	解析可能有無	1	1013
		経度方向範囲（度）	6	1014
		緯度方向範囲（度）	160	1015
	面積	解析可能有無	0	1016
		経度方向有無	0	1017
		緯度方向有無	0	1018
	方位	解析可能有無	0	1019
		経度方向有無	0	1020
		緯度方向有無	0	1021
図法固有情報 (1022)		ゾーンNo. 最小	0	1023
		ゾーンNo. 最大	60	1024
		基準経線（度）	180	1025
		予備	0	
		⁝	0	

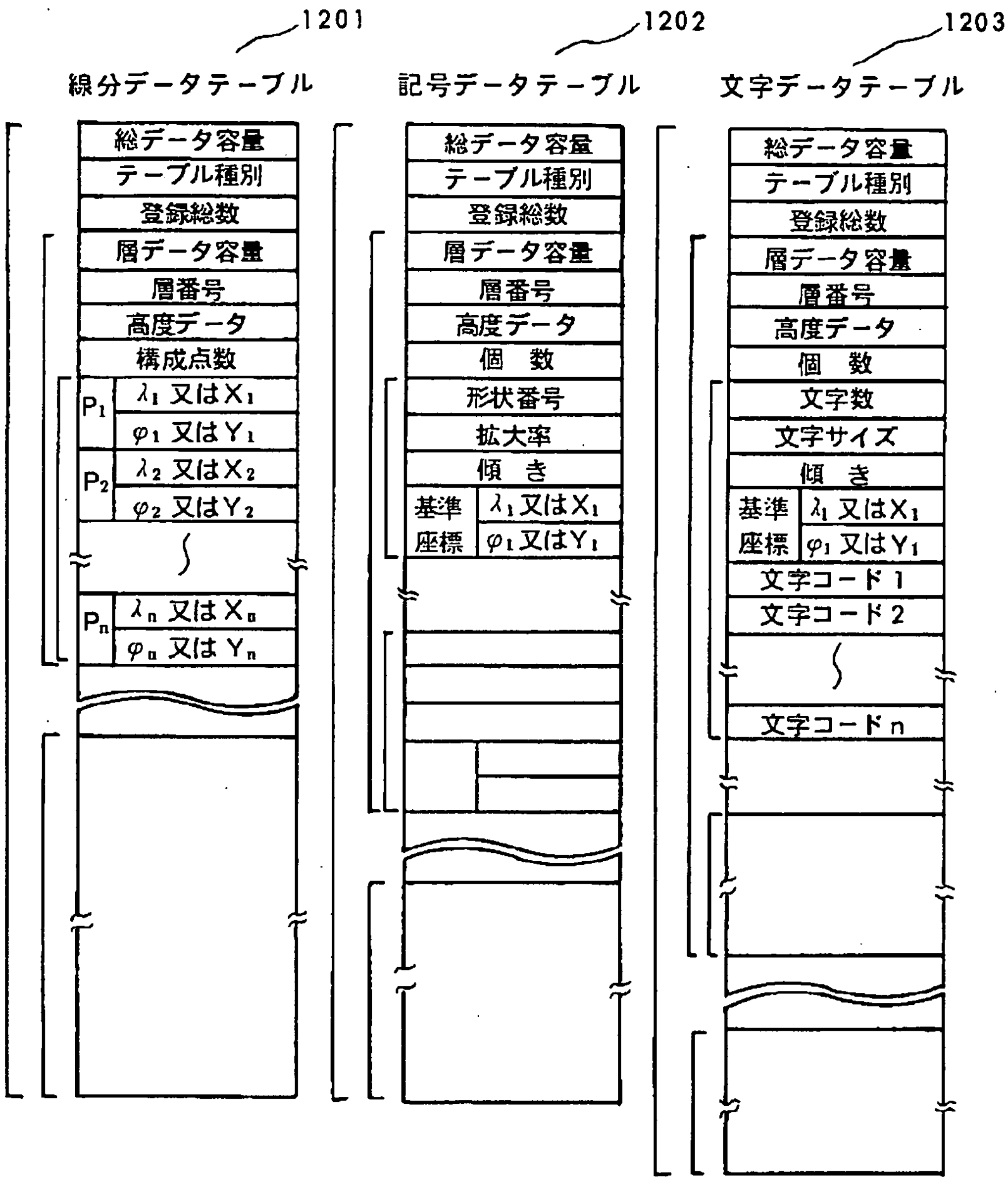
[Drawing 11]

図 11

図法ＩＤ			NRM	1101
特別図法区分			1	1102
図法分類		方位図法	0	1103
		円錐図法	0	
		円筒図法	0	
		正距図法	0	
		正角図法	0	
		正積図法	0	
表現可能範囲	経度	最小値	0	1104
		最大値	360	1105
	緯度	最小値	−80	1106
		最大値	80	1107
解析可能判定	距離		0	1108
			0	
			0	
	面積		0	
			0	
			0	
	方位		0	
			0	
			0	
図法固有情報			0	1109

[Drawing 12]

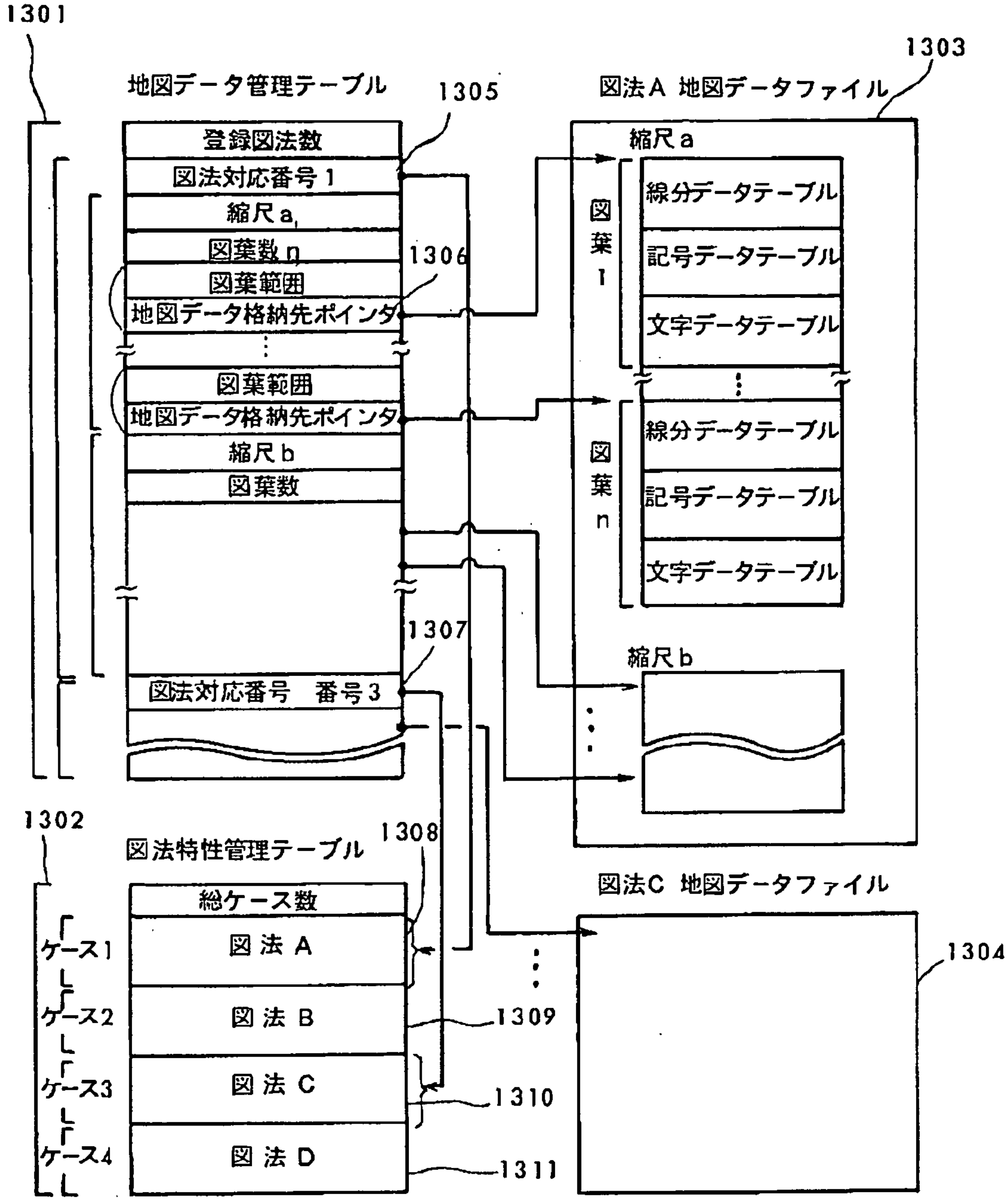
図 12



（λ，φ）座標系は，一般の図法による地図データに対応
（X，Y）座標系は，ＵＴＭ図法による地図データに対応

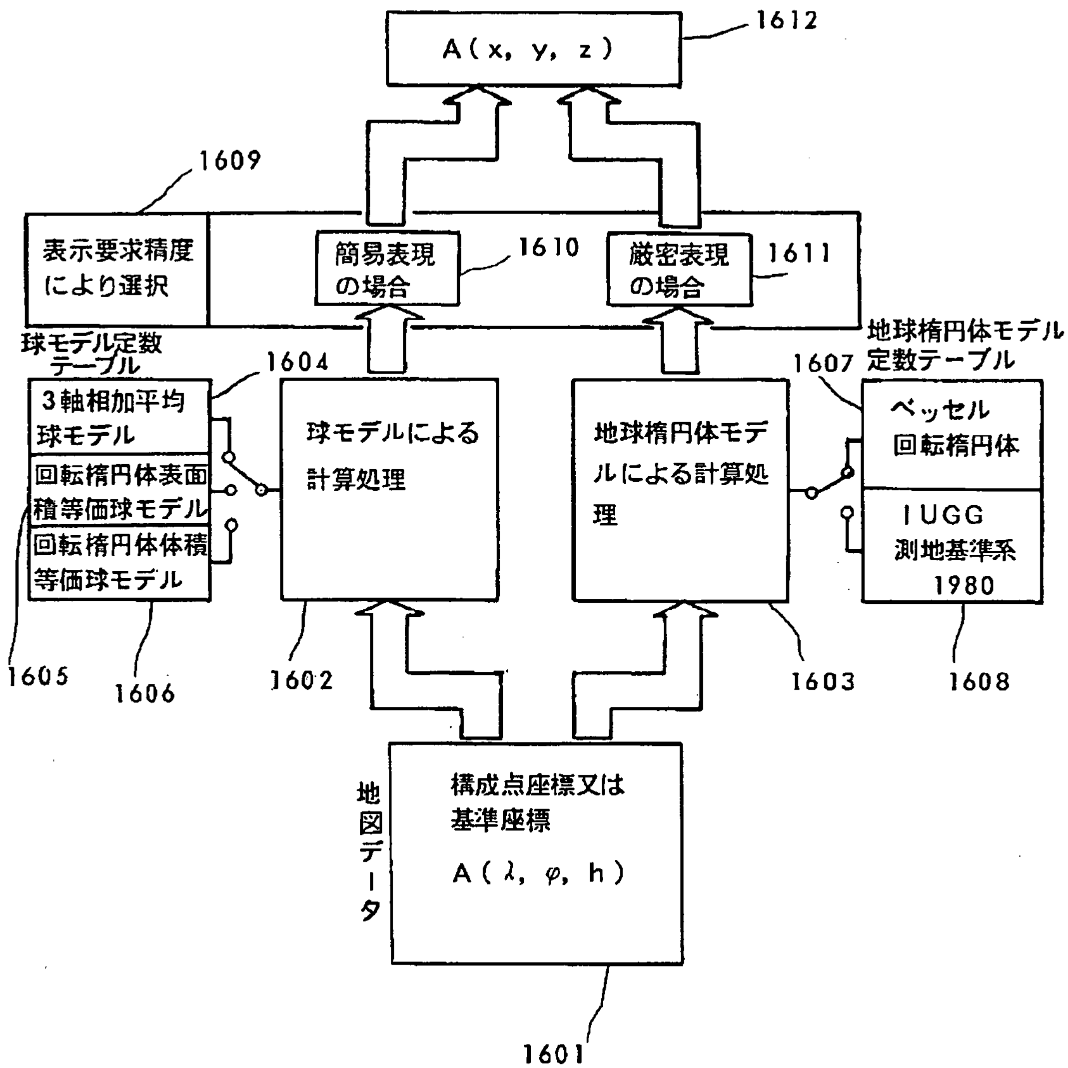
[Drawing 13]

図 13



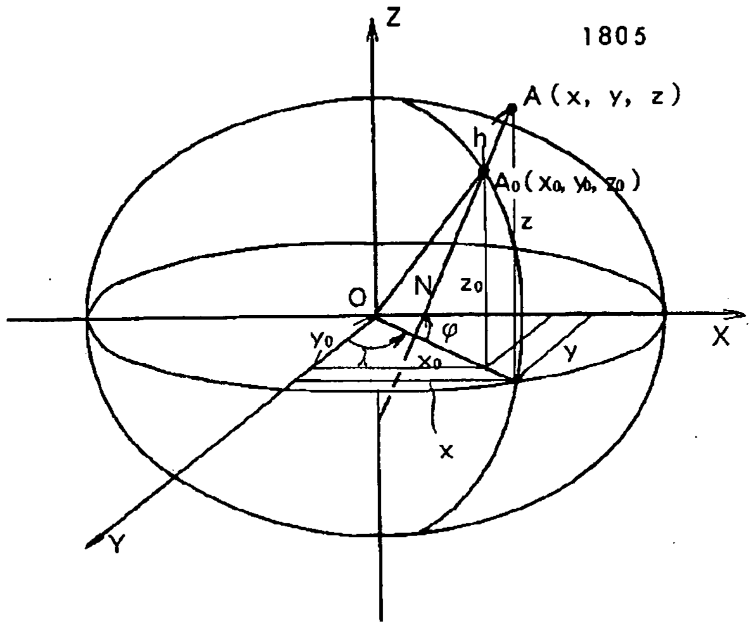
[Drawing 16]

図 16



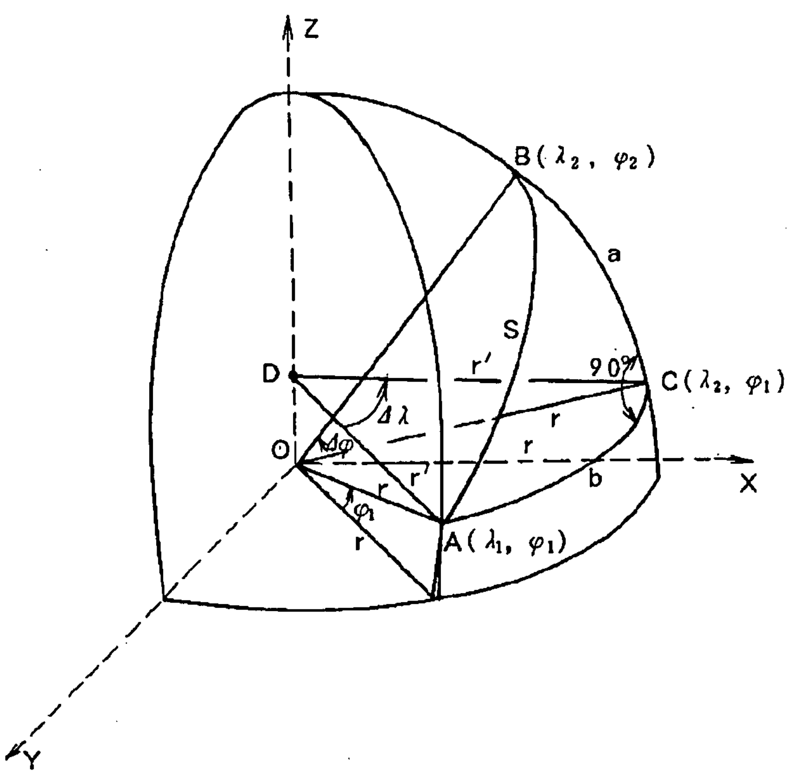
[Drawing 18]

図 18



[Drawing 20]

図 20

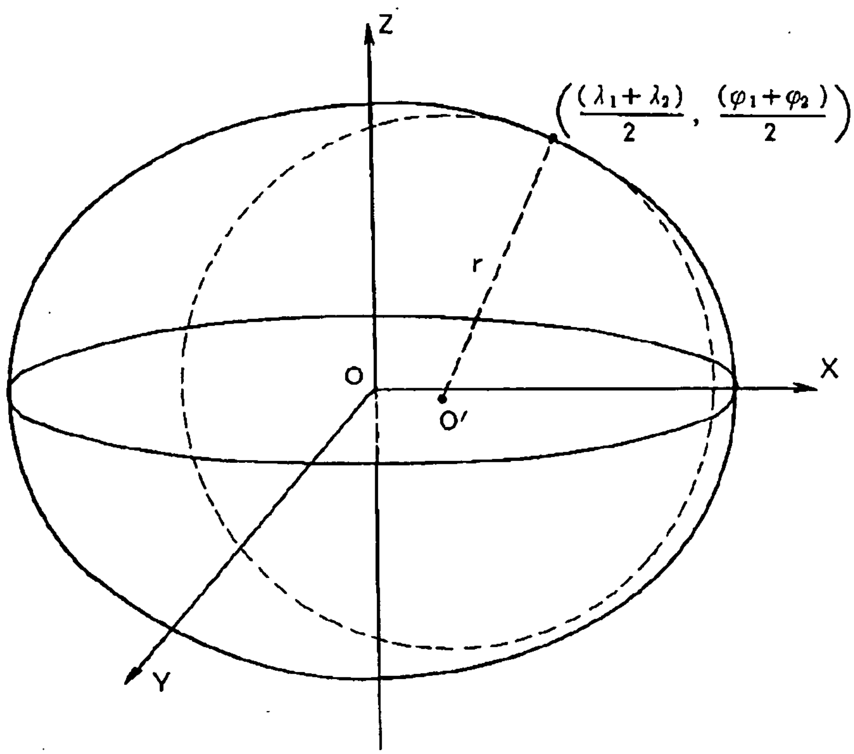


[Drawing 19]

ID=000021

[Drawing 21]

図 21



[Translation done.]